Root-cause Analysis
MMT-RCA

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Agenda

❖ Our approach and related research topics

❖ RCA with P4-Enabled 5G Network

❖ Demo
MMT-RCA: Knowledge-based approach

- **Signature-based:**
  - Historical data of known incidents and their symptoms (observed in monitoring data) + known root causes (~ labelled data)
  - Similarity?

- **Anomaly-based:**
  - Historical data of proper states (~ unlabelled data)
  - Dissimilarity? The change reflected in which metrics/attributes?

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**Signature-based:**
- **Detected incident**
- **Its symptoms are similar enough to the ones of a known incident?**

  - **Yes**
    - Suggest the root-cause, potential impacts, mitigation actions based on the experience with the known incident
  - **No**
    - How is it different from the known proper states?
      - **Expert's advice**
        - Update the historical data

**Anomaly-based:**
Related research topics

- **How to translate monitoring data to symptoms and vice versa?**
  - Heterogeneous data of different units / ranges:
    => Data normalization/ standardization
  - Data redundancy (noises/ too many dimensions):
    => Feature selection (5 selection models integrated)

- **How to measure similarity/dissimilarity between two sets of symptoms?**
  - Similarity/ Dissimilarity score calculation:
    - distance of **orientation** (the angle)
    - distance of **magnitude** (the length)

The system’s state can be characterized by a set of n attributes: \(<a_0, a_1, \ldots, a_n>\), which can be represented by a vector in n-dimensional space.
RCA with P4-Enabled 5G Network

Why P4?

Network Demands

Switch OS

Run-time API

Driver

Fixed-function ASIC

“This is *how I know* to process packets”
(i.e. the ASIC datasheet makes the rules)

Traditional approach
RCA with P4-Enabled 5G Network

Why P4?

Network Demands

Switch OS

Run-time API

Driver

Feedback

P4 Programmable Device

Data Plane Programming

“\textit{This is how I want} the network to behave and how to switch packets…”

(the user / controller makes the rules)

P4 approach
RCA with P4-Enabled 5G Network

Why P4?

- Packet is parsed into individual headers (parsed representation)
- Headers and intermediate results can be used for matching and actions
- Headers can be modified, added or removed
- Packet is deparsed (serialized)
/* From core.p4 */
extern packet_in {
    void extract<T>(out T hdr);
    void extract<T>(out T variableSizeHeader,
                      in bit<32> variableFieldSizeInBits);
    T lookahead<T>();
    void advance(in bit<32> sizeInBits);
    bit<32> length();
}

/* User Program */
parser MyParser(packet_in packet,
               out headers hdr,
               inout metadata meta,
               inout standard_metadata_t std_meta) {

    state start {
        packet.extract(hdr.ethernet);
        transition accept;
    }
}

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Demo

- RCA analyzes in real time possible CMWs status.
  - **Failures 1:** Gateways are disconnected.
  - **Failures 2:** Services are disconnected.
- RCA tool provides a report in the ITS Safety internal protocol format.
Thank you for your attention!

**Acknowledgment:**
The research conducted by INSPIRE-5Gplus receives funding from the European Commission H2020 programme under Grant Agreement No. 871808. The European Commission has no responsibility for the content of this presentation.